Fungal transformation of lignite in overburden dumps

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Acidity in overburden dumps of open cast lignite mines poses a considerable environmental threat. Despite the persistence of the dump organic material (lignified organic matter), microbial acidity attenuation processes such as iron sulphide formation by microbial sulphate reduction were observed within several dumps (Storch *et al.*; 2007). Fungi are known for their ablility to liquefy lignite (Ward; 1985). Therefore, autochthonous acidotolerant fungi may provide bacterial substrates by transformation of lignite into water soluble organic matter.

Methods

Autochthonous fungal strains were isolated from dump material of the Plessa field site (Lusatia, Gemany). The sediment was placed on Sabouraud glucose agar and incubated at 20°C. After formation of a thick hyphae mat identical dump material was placed on this mat. A few days later bioliquefaction of lignite particles started.

Results

The autochthonous fungies (*Mucor hiemalis*) transformed lignite particles into black and shiny droplets of very high organic carbon contents (~15 g/L). The liquid product was analysed by gel chromatography to consist of humic substances (a), building blocks (b), low molecular weight substances (c), neutral substances (d), and polysaccharides (e). The liquefied organic matter is highly polar and water soluble. HPLC analysis (Schmalz *et al.*; 2002) of the water dissolved droplets revealed the predominance of carbonylic and carboxylic functional groups. Carbonic acids are well known substrates for sulphate reducing bacteria (Widdel; 1988).

fig. 1: liquefied lignite

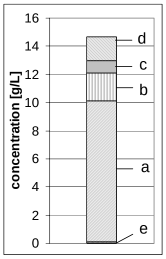

fig. 2: DOC fractions

References

Storch, A., Hoth, N., Tröger, K., Knöller,K. (2007) *17th Internat. Biohydrometallurgy Symp.* (IBS 2007) Frankfurt

Ward, B., (1985). System. Appl. Microbiol. **6**. 236-238

Schmalz, L.; Rossner, U.; Grupe S., (2002). *Vom Wasser* **99**. 63-78

Widdel, F. (1988) in Zehnder, A.J. *Biology of anaerobic microorganisms*, Wiley and sons New York. 469-585

Isotopic fractionation of Uranium in low-temperature environments

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Uranium is the heaviest naturally occurring element and mass-dependent isotopic fractionation between ^{235}U and ^{238}U, which scales with $\delta M/M^2$, is not normally considered significant given the small ~1% difference in mass. It is therefore usual to assume that ^{238}U/^{235}U is constant in the terrestrial environment and equal everywhere to 137.88 at the present day. Importantly, isotopic fractionation of the very heavy elements has recently been investigated for mercury and thallium in the context of mass-independent nuclear field shift effects[1], which do not scale with $\delta M/M^2$, and are predicted to have permil-level effects on the heavy masses, including uranium.

We have developed experimental protocols for the precise measurement of ^{238}U/^{235}U and ^{238}U/^{234}U by multiple-collector ICPMS (MC-ICPMS) to investigate potential isotopic fractionation in uranium. Using multiple-Faraday protocols and a high-purity ^{233}U-^{236}U double spike to internally monitor instrumental mass bias effects, we are able to resolve variations in ^{238}U/^{235}U and ^{238}U/^{234}U at the 0.4 and 0.3 epsilon level (2σ; 1 epsilon = 1 part in 10,000), respectively. Measurements for samples formed in a range of low-temperature environments reveal sizeable, permil-level natural variability in ^{238}U/^{235}U[2]. Present experiments are focussed on the isotopic fractionation of uranium during the biologically-mediated reduction of U(VI) to U(IV).

Our new observations indicate that uranium isotopic fractionation of ^{238}U/^{235}U may offer the potential to monitor biological pathways and redox processes occurring during mineralization, weathering, and the transition between the U(IV) and U(VI) oxidation states, offering new insight into the processes at work. Moreover, variability in ^{238}U/^{235}U will have a direct bearing on the U-series and U-Th-Pb chronometers, when applied to samples formed in low-temperature environments, as these chronometers currently assume an invariant ^{238}U/^{235}U equal to 137.88.

References

Schauble E.A. (2007). *Geochim. Cosmochim. Acta* **71**, 2170-89

Stirling C.H., Andersen M.B., Potter E.-K and Halliday A.N. (2007). *Earth Planet. Sci. Lett.* accepted for publication.